The Summer Undergraduate Research Fellowship (SURF) Symposium
7 August 2014
Purdue University, West Lafayette, Indiana, USA

Thermal Properties of Soft Nanomaterials: Materials Synthesis and Fabrication

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ABSTRACT

The properties of soft nanomaterials are hard to measure exactly due to their mechanical properties and unstable shape. In particular, hydrogels are a class of cross-linked polymers that can absorb large quantities of water changing their shape under the influence of various conditions such as humidity, temperature, and pH. This research addresses the fabrication of a material that has a significant contrast in properties under different conditions (e.g. temperature, wetting, and pH) and determine the physical mechanisms of heat transfer in this nanomaterial. The hydrogels are made using a several cycles of a freeze-thaw method. The method requires soluble material. We set the solution in chamber slide which give us a rectangular shape. We freeze the sample under -20 □ C for 21 hours and thaw at room temperature for 3 hours. The 3ω method measures the thermal conductivity of the soft nanomaterials including a polyvinyl alcohol (PVA) – polyvinyl pyrrolidone (PVP) hydrogel and a PVA-Dimethyl sulfoxide(DMSO) hydrogel. By analyzing the magnitude and the phase of the temperature response to a heating signal, we determine the thermal conductivity of each material. To enhance the thermal transport, these materials are embedded with gold nanoparticles. By comparing experimental value with theoretical value, we conclude fabrication methods have a significant impact upon the material properties. Further research will be focusing on different soft nanomaterials and include the impact of the nanoparticle concentration and hydrogel fabrication methods.

KEYWORDS

3-omega method; soft nanomaterial; hydrogel; polyvinyl alcohol; PVA; Dimethyl sulfoxide; DMSO; polyvinyl pyrrolidone; PVP; thermal conductivity;

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